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# Managing Memory in a DOS Workstation: Using Novell DOS 7

*Valerie O'Connor*
Technical Support Analyst
NSG Technical Support

*Robert Rodriguez*
Technical Support Analyst
NSG Technical Support

This AppNote is the third in an ongoing serious that explains how to use various memory managers to maximize the amount of workstation memory available for running applications. This AppNote looks at Novell DOS 7, which includes a complete suite of integrated memory managers for 80286 and 80386 (or better) class computers. This integration provides Novell DOS with the ability to relocate the operating system outside of Conventional Memory and to provide all of the various memory specifications needed for today's applications. This AppNote explains all of the options available with the various Novell DOS 7 memory managers. In addition, explanation of the switches and troubleshooting tips are included.

**Previous AppNotes in This Series**

Managing Memory in a DOS Workstation: Using MS-DOS 5.0 and Windows 3.1 (Oct 92)

Managing Memory in a DOS Workstation: Part 1 (Aug 92)

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## Introduction

DR DOS 5 was the first retail DOS (Disk Operating System) to offer integrated memory management. Since its introduction in 1990, memory managers have become a prerequisite for the modern DOS. With each succeeding generation of operating systems, the tasks these memory managers perform have become more complex.

DR DOS 6 brought with it a tighter integration of memory management and operating system--including the ability to automatically load certain utilities into Upper memory.

Novell DOS 7 takes the integration of memory management and operating systems (Oses) to new levels with the introduction of DOS Protected Mode Services (DPMS).

This AppNote introduces the memory management programs supplied with Novell DOS 7. These are:

- DMPS.EXE
- EMM386.EXE
- HIMEM.SYS
- EMMXMA.SYS

For more information concerning general memory management concepts, see Managing Memory in a DOS Workstation: Part 1 in the August 1992 NetWare Application Notes.

## CPU Modes

Before discussing the Novell DOS memory manager options, it is important to have an understanding of CPU (Central Processing Unit) modes. This section summarizes CPU modes and provides a general background on why memory management was developed.

The 20-bit 8086 address bus was the first PC architecture. Its total number of addressable bytes equals 1 MB (megabyte). This is, in part, where the DOS 1 MB address space limitation originated.

Figure 1 shows the basic DOS memory architecture. The principal memory zones are labeled along with what applications or specifications make use of them. For example, Low memory is used for DOS and BIOS data areas. Extended memory is used by EMM386 for XMS, EMS, DPMI, VCPI, and Int15. HIMEM.SYS uses extended memory for XMS and Int15. DPMS also uses extended memory.

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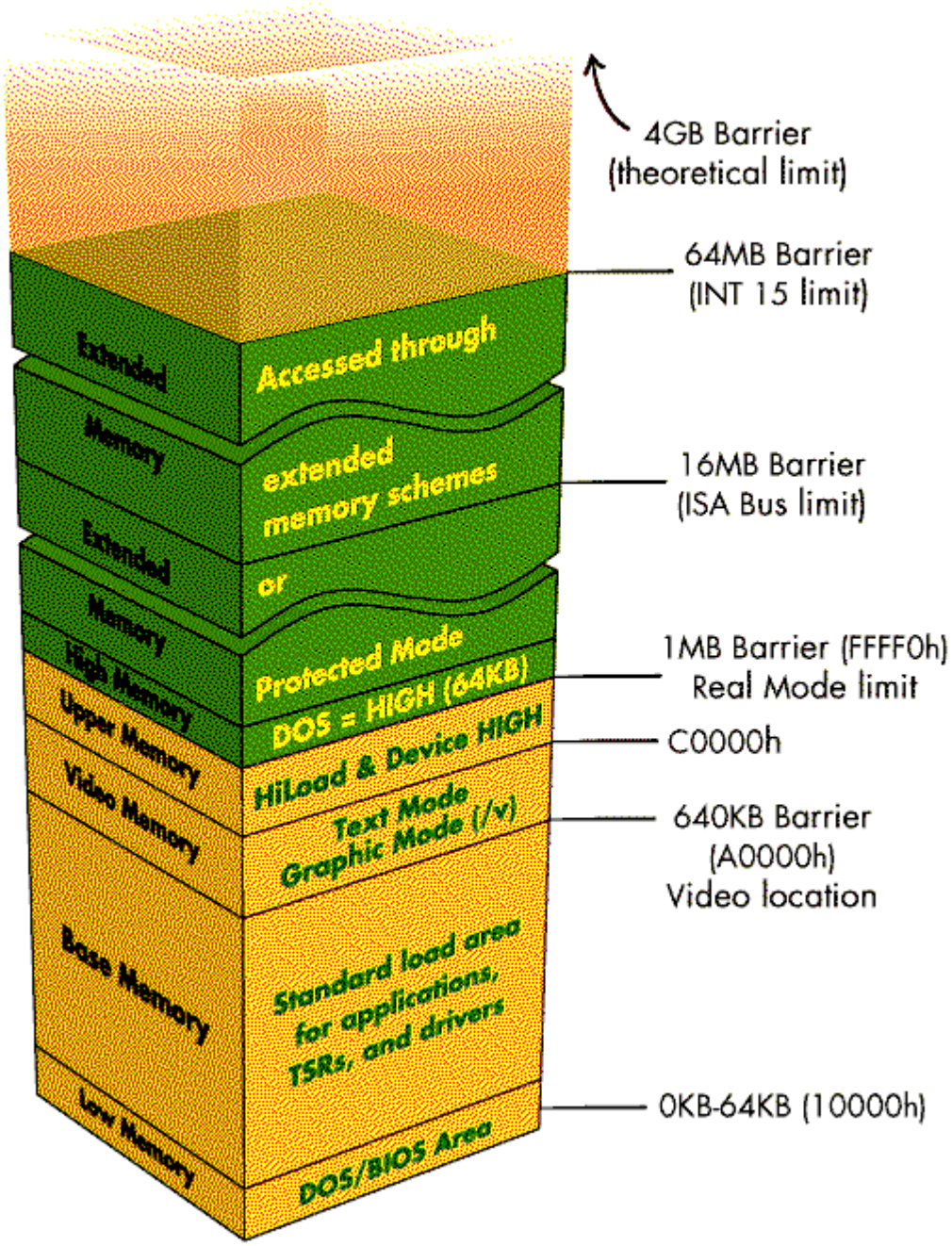


Figure 1: DOS Memory architecture.

The 286 (80286) address bus was developed as 24-bit, which equates to 16 MB of addressable memory. However, because DOS used the older 8086 memory model, it was not able to directly access this much memory. To maintain compatibility with DOS, the 286 has two modes of operation: Real and Protected.

When a 286 operates in Real mode, memory addressing is similar to that of an 8086. Real mode is compatible with DOS and has a maximum address space of 1 MB.

In Protected mode all 16 MB of memory is addressable. With Protected mode came the introduction of

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privilege levels. Privilege levels, sometimes called ring levels, are where the system software kernel has control over an applications environment.

Figure 2 gives a graphical representation of privilege levels. In the case of Novell DOS 7, the memory manager assumes responsibility of the kernel position or Ring 0. The kernel controls access to memory for all less privileged applications. In Figure 2, the drivers would be at Ring 1 and the applications would be at Ring 2.

In addition, the kernel also controls whether or not the CPU is in Protected mode. The kernel will switch to V86 (in 386's) or Real mode for DOS services.

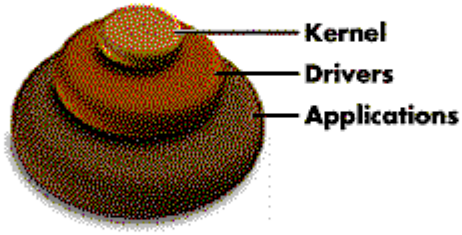


Figure 2: Protected mode privilege levels.

The need for more than one megabyte of usable RAM drove software vendors to create the following memory specification standards:

- EMS (Expanded Memory Specification),
- XMS (Extended Memory Specification),
- other DOS extenders (such as those created by Phar Lap).

These standards filled a void by providing a standard specification for developers to use when switching the CPU between Real and Protected mode. Protected mode allows access to 16 MB of RAM and Real mode allows access to DOS and its functions.

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However, early 286 chips did not have a safe, simple way to return to Real mode from Protected mode. The process was cumbersome and time consuming. The advantage of being able to switch between modes was the ability to access more than 1 MB of usable RAM.

The 386 (80386) address bus is 32-bits wide. This means that there can be a total of 4 GB (gigabytes) of usable memory. However, not all 386 computers can actually use this much memory. In fact, a number of 386 machines have a BIOS (Basic Input/Output System) based on the original 286 AT implementation using DMA (Direct Memory Access) chipsets that are also based on the AT. A 386 computer with an AT style BIOS and DMA is limited to a maximum usable memory of 16 MB.

**Note:** When we refer to 386 computers in this AppNote, we are referring to 386, 386SX, and 486 or better computers.

Other 386 computers have a limit of 64 MB of RAM. This limit is a function of a BIOS call. The INT 15 function 88 call returns the total extended memory on the system. The highest number that can be returned is 64 MB.

The 386 CPU family has the same two modes as the 286. Improvements in technology allow this family of CPUs to efficiently switch from Protected mode back to Real mode. Additionally, the 386 does not have to return to Real mode to support DOS because there is a third memory mode in this CPU family: V86 mode.

V86 (Virtual 86) mode is a form of Protected mode that supports addressing similar to that of Real mode. The V86 mode can be easily switched to full Protected mode and back to V86. In addition, there can actually be several V86 address spaces supported at one time.

## Relocating DOS

Loading the operating system in Upper and High memory is mainly controlled by the CONFIG.SYS statement

DOS=HIGH | UMB | LOW

If there isn't any extended memory, the operating system software is loaded in Lower memory (the first 64K of Conventional memory). If the computer has extended memory, however, you can make more Conventional memory available to your applications by allowing the Novell DOS memory managers to load the DOS software high. The HMA (High Memory Area) is the default location for the operating system (DOS=HIGH).

**Note:** The HMA is only available on 286 or greater computers. The Novell DOS Memory Manager will determine if the HMA is available.

If the HMA is not available, DOS is loaded into Upper memory (DOS=UMB). If Upper memory is not available either, the system software is loaded in Conventional memory (DOS=LOW). In order for High or Upper memory to be enabled, a memory manager (such as EMM386.EXE or HIMEM.SYS) must be loaded.

Novell DOS makes very effective use of the HMA. In the sample below, DOS kernel and BIOS code, as well as buffers, are loaded into the HMA. In addition, COMMAND.COM, SHARE, and KEYB can also be loaded into the HMA.

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| Address | Name | Size (Hex./Dec.) | | Type |
|---|---|---|---|---|
| FFFF:1590 | DOS | FA0h | 4,000 | DOS BIOS code |
| FFFF:2530 | DOS | 6C80h | 27,776 | DOS kernel code |
| FFFF:91B0 | DOS | 1F2Ch | 7,980 | BUFFERS = 15 disk buffers |
| FFFF:B0DC | --- | 1CB1h | 7,345 | FREE |
| FFFF:CD8D | SHARE | 1173h | 4,467 | Program |

Figure 3: Memory usage by Novell DOS in the HMA.

Upper memory created by EMM386.EXE or HIMEM.SYS can also be used to relocate DOS structures, including the relocation of the memory manager itself. Upper memory can be used to relocate drivers and TSR (terminate and stay resident) programs.

In Figure 4, TSR programs such as the mouse and ANSI.SYS (reported as CON), as well as network drivers and DOS system structures, are located in Upper memory.

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| Address | Name | Size (Hex./Dec.) | | Type |
|---|---|---|---|---|
| C000:0000 | --- | 6000h | 24,576 | ROM |
| C800:0000 | EMS | 10000h | 65,536 | EMS memory |
| D800:0000 | EMM386 | 180h | 384 | XMS Upper Memory Block |
| D818:0000 | DOS | 410h | 1,040 | XMS Upper Memory Block |
| D859:0000 | DOS | 1090h | 4,240 | System |
| D85B:0000 | CON | 1070h | 4,208 | DEVICE = installed device driver |
| D962:0000 | DOS | 24B0h | 9,392 | System |
| D964:0000 | MVPROAS | 2490h | 9,360 | DEVICE = installed device driver |
| DBAD:0000 | DOS | 3340h | 13,120 | System |
| DEE1:0000 | MOUSE | 110h | 272 | Environment |
| DEF2:0000 | MOUSE | 3670h | 13,936 | Program |
| E26C:0000 | LSL | 1390h | 5,008 | Program |
| E3A5:0000 | NE2000 | 1430h | 5,168 | Program |
| E4E8:0000 | IPXODI | 3FC0h | 16,320 | Program |
| E8E4:0000 | NWCACHE | 1450h | 5,200 | XMS Upper Memory Block |

Figure 4: Memory usage by Novell DOS in Upper memory.

## DPMS.EXE

The newest tool contained in Novell DOS for maximizing available memory is called DPMS (DOS Protected mode Services). DPMS is a suite of services which allow DOS devices and other resident system extensions (such as TSR's and disk drivers) to run in Protected mode on 286 and 386 computers. By using DPMS services an application can reliably execute in and/or store data in extended memory. This reduces the use of Conventional memory (leaving it free for applications that require Conventional) without the need to use the Upper memory or High memory areas.

DPMS is tailored to meet the requirements of TSR applications. It has a minimal suite of services, which results in DPMS having a very small footprint of about 1K in Conventional memory. Novell DOS 7 includes the following DPMS client components:

- The Stacker disk compression driver
- NWCACHE (disk cache)
- CD-ROM extensions
- A peer-to-peer network server
- VDISK

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DPMS services are provided by the DPMS server which is loaded in CONFIG.SYS. DPMS is DOS and memory manager independent and is compatible with Windows versions 3.0 and 3.1.

The DPMS API (Application Programming Interface) is available as a Software Developers Kit (SDK) to third-party developers. Developers will be able to license and distribute DPMS free of royalty charges. The DPMS SDK is available through Novell's Professional Developers Program by calling 800-RED-WORD (800-733-9673).

## EMM386.EXE

EMM386.EXE provides access to Upper memory. It also uses extended memory to emulate EMS memory for those applications that require it. The close integration of EMM386.EXE with the operating system permits key operating system components to automatically relocate themselves outside of Conventional memory.

## EMM386 Command Line Options

With the change from EMM386.SYS to EMM386.EXE, Novell DOS's 386 memory manager can be run from both the CONFIG.SYS and the command line. The following is an example of EMM386 command line options:

EMM386 [|HELP] [AUTO] [OFF] [ON] [WEITEK={ON|OFF}]

? or HELP displays the help screen

**AUTO**. The AUTO switch makes changing between ON and OFF automatic. The AUTO switch is the default when EMM386.EXE runs without any overriding switches.

**OFF**. The OFF switch places EMM386.EXE permanently in Real mode with Upper memory and EMS permanently disabled. The OFF switch cannot be used if Upper memory or EMS (LIM) is being used.

At first glance, using the OFF switch from the command line seems unnecessary. What would be the purpose of running a memory manager and not using upper memory or EMS? The OFF switch is an excellent diagnostic tool for troubleshooting memory manager and BIOS conflicts. Also, the OFF switch can be used with older DOS applications that assume that the computer is in Real mode. These programs would also not be aware of interfaces such as DPMI (DOS Protected Mode Interface) or VCPI (Virtual Control Program Interface).

To use the ON|OFF combination, simply add the switch /OFF to the EMM386.EXE line in CONFIG.SYS. This prevents EMM386.EXE from creating any Upper memory or EMS. When this line is added, EMM386.EXE will be loaded, but the computer will be functioning in Real mode. Entering the command EMM386 ON will switch the machine into Protected mode. The configuration of the system has not changed, so any conflicts or changes in the computer can be attributed to being in Protected mode.

**ON**. The /ON switch turns EMM386.EXE on permanently in Protected/Virtual 8086 mode.

**WEITEK={ON|OFF}**. This enables or disables the Weitek coprocessor (if one is installed). The Weitek switch allows command line enabling and disabling of the coprocessor. The default is OFF. The Weitek coprocessor maps into and out of the HMA so that DOS applications can access it. EMM386.EXE can make much better use of the HMA by using it for the relocation of DOS structures such as COMMAND.COM. If an application requires the use of the Weitek coprocessor, the Weitek switch should be turned on. The proper use would be to add the switch /WEITEK=ON to the EMM386.EXE line in the CONFIG.SYS. It can then be disabled or enabled from the command line.

## DPMI.EXE

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In addition to the available command line switches for EMM386.EXE, there is a utility called DPMI.EXE which will make changes to the EMM386 configuration. The following are the DPMI.EXE options that are available:

DPMI [/Help] [On] [Off]

Using the On switch enables DPMI support.
Using the Off switch disables DPMI support.

If no parameter is specified, then the current state of DPMI is shown.

As the command line options suggest, it is possible to disable and enable DPMI support with this utility. The DPMI server must be enabled for DPMI.EXE to function. The DPMI server is enabled by including the /DPMI or /Multi switches in the EMM386.EXE line in CONFIG.SYS.

You may need to disable DPMI support to maintain compatibility with some DOS applications. For example, some VCPI (Virtual Control Program Interface) applications may need to have DPMI disabled in order to run.

## EMM386 Switches in CONFIG.SYS

EMM386.EXE is loaded and configured by using a DEVICE= statement in the CONFIG.SYS file. The DEVICE=EMM386.EXE line is added to the CONFIG.SYS file automatically by the SETUP or INSTALL utility when the 80386 memory manager option is chosen. The switch values are determined by the selections made during SETUP or INSTALL, or by changes made directly to the CONFIG.SYS EMM386.EXE line.

The full syntax of the EMM386 DEVICE statement is as follows:

DEVICE = C:\NWDOS\EMM386.EXE [[/]|[/]H] [[/]AUTO]
[[/]COMPAQ] [[/]DPMI] [[/]EXCLUDE=start-end]
[[/]FRAME=AUTO|NONE|address]
[[/]GATEA20=type] [[/]INCLUDE=start-end]
[[/]INTI5=kb] [[/]MULTI] [[/]OFF] [[/]ON]
[[/]ROM=start-end] [[/]USE=start-end]
[[/]VIDEO=[start-end] [[/]VXD=path]
[[/]WEITEK=ON|OFF] [[/]WINSTD] [[/]XBDA]

/**AUTO**. EMM386.EXE defaults to /AUTO. The memory manager will switch to Protected mode if no other Protected mode memory manager has been enabled, and will switch back and forth from Real to Protected mode as needed.

/**COMPAQ**. This switch makes an additional 256KB of memory available as extended memory on Compaq 386 machines.

/**DPMI**. This switch enables DPMI support. The DOS Protected Mode Interface for Novell DOS is compliant with the DPMI 0.9 specification.

DPMI (DOS Protected Mode Interface) uses a host/client concept where the client has fewer privileges than the host (described earlier as privilege levels). This interface provides access to Real or V86 mode to service DOS calls. Because the DPMI host (EMM386.EXE) provides access to all Real/V86 mode functions, it can change the client application's DOS environment to reflect something other than the true physical environment. This means that DPMI can create multiple DOS machines which permits it to provide service to more than one application at a time. DPMI support is required for the Novell DOS Task Manager.

/**EXCLUDE**. This switch forces EMM386.EXE to exclude a specified area of upper memory from use. The syntax is:

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/EXCLUDE=start-end

The starting address should be in the format xx00 while the ending address should be xxFF. The address is hexadecimal. An example of the correct use of this switch would be:

/EXCLUDE=D000-D7FF

Some devices, such as network interface cards, use Upper memory. A conflict with EMM386.EXE can occur because these cards do not use memory until they are initialized (usually by loading a driver from a batch file). Because the card does not use memory until after EMM386.EXE has loaded, the only way to resolve the conflict is to use an EXCLUDE statement to prevent EMM386.EXE from using the same memory addresses as the card.

/**FRAME**. Enables EMS or LIM memory emulation. The syntax is:

/FRAME=AUTO | NONE | address

AUTO enables EMS and lets the memory manager locate the page frame. NONE disables EMS support. Address is the location where the EMS page frame is to be created. The address must be specified as a four digit hexadecimal value. A switch of /FRAME=D000 will enable EMS support with the page frame located at D000.

XMS (e**X**tended **M**emory **S**pecification) is always supported by EMM386.EXE no matter what the /FRAME switch is set to. EMM386.EXE is compliant with the XMS 3.0 specification.

EMS (**E**xpanded **M**emory **S**pecification) is available only when /FRAME=AUTO or /FRAME=address. EMS is sometimes referred to as LIM (Lotus-Intel-Microsoft) memory specification. EMM386.EXE is compliant with the LIM 4.0 specification.

VCPI (Virtual Control Program Interface) is supported using all possible combinations of the /FRAME switch. Technically, VCPI is an extension of EMS. It was originally intended to allow EMS and DOS extenders to coexist. It was created by the same group (Lotus-Intel-Microsoft) that created EMS. While VCPI is supported with /FRAME=NONE, some VCPI applications require a page frame before they recognize EMM386.EXE as a VCPI host.

VCPI does not use privilege levels. As a result, host and client are equivalent, and each manages its own environment. This means that virtualization of hardware for VCPI clients is not possible. Therefore, multitasking multiple VCPI clients is not possible.

/**GATEA20**. This switch specifies how EMM386.EXE will handle control of the address line A20. The correct syntax is:

/GATEA20=type

where type can be PS2, AT, XMS, or HP. The memory manager should automatically detect the machine type. However, if this is not the case, this switch can be added.

/**INCLUDE**. This switch is the reverse of /EXCLUDE. It forces EMM386.EXE to include a block of upper memory. The test applied to the memory is far less stringent. As with /EXCLUDE, the upper memory addresses to be included must be specified in hexadecimal format. The syntax is:

/INCLUDE=xx00-xxFF

An example of an INCLUDE would be

/INCLUDE=B000-B7FF

As a rule, EMM386.EXE does not map any video space for inclusion as Upper memory. The address range

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B000-B7FF is used for Hercules video display. This region can be used with /INCLUDE to gain an additional 32K of upper memory.

**Important:** If Windows is installed, the memory address range B000-B7FF should not be included unless the driver MONOUMB.386 is loaded.

/**INT15**. The INT15 switch reserves a specified amount of extended memory. This memory will not be used for XMS, EMS, or any other type of memory specification. This allows third party software with built-in memory managers to function, while still allowing EMM386.EXE to perform its task of relocating DOS. The syntax is:

/INT15=XXXX

where XXXX is a decimal value specifying the number of kilobytes to be set aside.

/**MULTI**. This switch provides DPMI support for the Novell DOS multitasking software. This switch is automatically added by SETUP when the Task Manager is enabled.

/**OFF**. This switch turns off EMM386.EXE. This means the computer will remain in Real mode until the ON switch is used from the command line.

/**ON**. This switch turns EMM386 on. Once EMM386 is on, the computer will then remain in Protected or V86 mode until the OFF switch is used at the command line.

/**ROM**. The ROM switch copies ROM (Read Only Memory) into RAM (Random Access Memory). This accelerates the operating speed of the computer because RAM executes faster than ROM. The function that this switch performs is commonly called ROM shadowing (or simply shadowing). The valid syntax is:

/ROM=AUTO|NONE|start-end

AUTO copies all available ROM to RAM. NONE disables any copying and start-end copies only the specified address. As in all other examples, the address must be in hexadecimal format.

/**USE**. /USE forces EMM386.EXE to scan a specified area of Upper memory for usable memory. The syntax is:

/USE=start-end

The start and end addresses specify the area to be scanned. Addresses are in hexadecimal values. This switch differs from the /INCLUDE switch in that EMM386.EXE will first verify that the memory is usable. The /INCLUDE switch uses a reduced test of the specified address range.

/**VIDEO**. This switch makes unused video memory available to applications when it is not being used by the video card. The address range to use can be specified, but the normal method is to use /VIDEO with no parameters. EMM386.EXE will determine the amount of memory to use. The correct syntax to use is:

/VIDEO=start-end

The start and end must be valid hexadecimal addresses between A000 and B7FF.

Using the /VIDEO switch, Hercules, EGA, and VGA cards can get an additional 64K of Conventional memory. CGA cards can get 96K more Conventional memory. EGA and VGA cards will only be able to get the additional memory as long as the video card is in text mode. The command MEMMAX +V enables the use of the additional memory while MEMMAX -V disables it.

/**VXD**. This specifies the location of Novell DOS VxDs (Virtual Device Drivers) when using Windows 3.0 or 3.1 in enhanced mode. The default is for the VxD to be located in the same directory where the memory manager was loaded. If the VxD is not located in the same directory, the switch /VXD=path is added to the EMM386.EXE line so that the drivers can be located and loaded. The path must be a full valid DOS path

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such as C:\NWDOS. Normal installation of Novell DOS 7 will correctly place all VxDs.

/**WEITEK**. This enables or disables the Weitek coprocessor (if one is installed). The correct syntax is:

/WEITEK=ON|OFF

**Note:** Refer to the section on EMM386.EXE Command Line Options for a more detailed explanation of how the Weitek option is used.

/**WINSTD**. This switch provides support for Windows 3.0 standard mode (286 mode). Windows 3.0 in standard mode requires that Upper memory be disabled. This switch does not need to be used for Windows 3.1 standard mode.

The /WINSTD switch can also be used to diagnose memory manager conflicts. It helps distinguish between a conflict with Protected mode and a conflict with Upper memory. If an application works with /WINSTD and does not work without the switch, then the application is not compatible with Upper memory, but can function in Protected mode.

/**XBDA**. This keeps the XBDA (e**X**tended **B**IOS **D**ata **A**rea) at the top of Conventional memory. Normally the XBDA occupies 1K of memory at the 639K mark. This is usually reflected in a MEM report as Total Conventional memory of 639K instead of 640K.

However, if /VIDEO is enabled, the memory manager will automatically move the XBDA to the bottom of Conventional memory to allow for increased contiguous memory at the top of the Conventional memory area.

## EMMXMA.SYS

EMMXMA.SYS is a memory manager that provides EMS memory support specifically for IBM PS/2 XMA memory cards. The extended memory on the card must be fully XMA compatible. EMMXMA.SYS will convert the extended memory to EMS and create a page frame in Upper memory.

## EMMXMA Switches in CONFIG.SYS

There are several different options available with EMMXMA.SYS. These switches are listed below.

/**FRAME**. This specifies the hexadecimal address for the page frame. If no /FRAME is specified, EMMXMA.SYS will automatically search upper memory between C000 and DFFF for a 64K contiguous block of memory.

When using the /FRAME switch, the correct syntax is:

/FRAME=address

/**KB**. The total amount of extended memory to be allocated for EMS is specified by this switch. If the /KB switch is not used, all available extended memory is used for EMS. The syntax is:

/KB=nnnn

where nnnn is the amount of memory to convert in kilobytes. This is a decimal value.

## HIMEM.SYS

HIMEM.SYS (formerly known as HIDOS.SYS) is the memory manager in Novell DOS that provides memory management capabilities for 286 machines. HIMEM.SYS can provide access to Upper memory as well as creating XMS 3.0 compliant extended memory.

Available features of HIMEM.SYS depend on the specific hardware being used. On a 286-based computer

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with at least 64K of extended memory, HIMEM.SYS can relocate the DOS software to High memory (DOS=HIGH in the CONFIG.SYS).

There are other HIMEM.SYS features available with certain chipsets or expanded memory boards. These Upper memory functions of HIMEM.SYS can be used with one or more of the following:

- A chipset such as Chips and Technologies NeAT or NeATsx, LeAPSet or LeAPSetsx, and SCAT
- An EMS or EEMS expanded memory board and driver (LIM 4.0 compliant)
- Permanent upper RAM

With any one of these chipsets HIMEM.SYS can initialize Upper memory only if Shadow RAM is enabled and available. The hardware setup program of the computer (normally invoked during bootup by a special key sequence) can be used to enable Shadow RAM. The setup program also allows the relocation of ROM into RAM.

## HIMEM.SYS EMS Upper Memory

HIMEM.SYS can also be used to create Upper memory from an EMS 4.0 compatible Expanded Memory board and EMS 4.0 driver. This accomplished by expanding the page frame from the normal 64KB to 128KB. HIMEM.SYS will then activate one of two options:

- The option /CHIPSET=EMSUMB will take 64KB of the 128KB page frame and use it for Upper memory. The remaining 64KB is used for EMS support.
- The option /CHIPSET=EMSALL will take all 128KB of the page frame and use it for Upper memory. EMS memory is no longer available, but using this method actually creates more Upper memory than the typical 120KB of a 386.

The EMS memory manager must be loaded before HIMEM.SYS in order for Upper memory to be created. Some configurable LIM cards also have the ability to provide extended memory at FFFF. If there is 64KB of extended memory at FFFF, HIMEM.SYS will also be able to use the HMA for DOS relocation.

HIMEM.SYS can be used on 386 machines with NeATsx or LeAPSetsx chipsets with favorable results. Keep in mind that HIMEM.SYS was not designed to create EMS memory.

HIMEM.SYS is loaded and configured by using a DEVICE statement in the CONFIG.SYS file. The HIMEM.SYS DEVICE line is added to the CONFIG.SYS file automatically by the SETUP or INSTALL utility when the 80286 memory manager option is chosen. The full syntax of the HIMEM statement is:

DEVICE = C:\NWDOS\HIMEM.SYS
[/CHIPSET=AUTO|chipset|NONE]
[/EXCLUDE=start-end] [/INCLUDE=start-end]
[/ROM=start-end|AUTO|NONE] [/USE=start-end]
[/VIDEO[=[start-]end] [/XBDA]

The switch values are determined by the selections made during SETUP or INSTALL or changes made directly to the CONFIG.SYS HIMEM.SYS line.

/**CHIPSET**. This switch specifies the chipset or the extended memory type of your computer. You may need to specify this information if the memory manager has difficulty mapping Shadow RAM into Upper memory. The proper syntax is:

/CHIPSET=AUTO|chipset|NONE

AUTO allows the memory manager to determine the chipset or memory type automatically.

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The following are valid chipset options:

NEAT Used for the Chips and Technologies NeAT, NeATsx, LeAPSet, or LeAPSetsx chipsets.

SCAT Used for the Chips and Technologies SCAT chipset.

EMSUMB Used for EMS4.0 or EEMS upper memory blocks. An EMS 4.0 or EEMS memory manager must also be loaded (see previous information about EMS).

EMSALL Used for all EMS upper memory (including page frame). This option disables use of EMS by all other programs (see previous information about EMS).

RAM Used for permanent upper RAM. You must also use the /USE option to define the location of the RAM to HIMEM.SYS.

NONE Used to disable mapping of shadow RAM. HIMEM.SYS will not create any upper memory.

**/EXCLUDE**. This switch forces the memory manager to exclude a specified area of upper memory when it searches for usable memory. The proper syntax is:

/EXCLUDE=start-end

The start and end parameters are the starting and ending addresses of the area to be excluded.

**/INCLUDE**. This switch forces the memory manager to apply a less stringent test to a specified area of Upper memory when it searches for usable memory. The proper syntax is:

/INCLUDE=start-end

The start and end parameters are the starting and ending addresses of the area to include.

**/ROM**. This option copies slow Read-Only Memory (ROM) into fast Random Access Memory (RAM). The proper syntax is:

/ROM=start-end|AUTO|NONE

The start and end specify the starting and ending addresses of an area of ROM to copy, AUTO copies all available ROM to RAM, and NONE disables copying.

**/USE**. This option forces the memory manager to use a specified area of upper memory when it searches for usable memory. The proper syntax is:

/USE=start-end

The start and end parameters are the starting and ending addresses of the area to use.

**/VIDEO=**. This option makes unused video memory available to applications. The address range to use can be specified, but the normal method is to use /VIDEO with no parameters. The proper syntax is:

/VIDEO=[start-]end

The [start-]end parameter must be valid hexadecimal addresses between A000 and B7FF.

Remember that video memory (Upper memory immediately above 640 KB) is normally reserved for use by the video display adaptor.

**[/]XBDA**. This option keeps the extended BIOS data area (XBDA) at the top of Conventional memory, for applications that require it to be there. The proper syntax is:

[/]XDBA

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However, if /VIDEO is enabled, the memory manager will automatically move the XBDA to the bottom of Conventional memory to allow for increased contiguous memory at the top of the Conventional memory area.

## Summary

In this AppNote, we have provided an overview of memory management concepts from the standpoint of the development of CPU architectures over time. We've covered why memory management is now an integral component of modern DOS-based workstations. This AppNote also provided an in-depth look at all of the memory manager options for Novell DOS 7 and suggestions on their use for workstation optimization.

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